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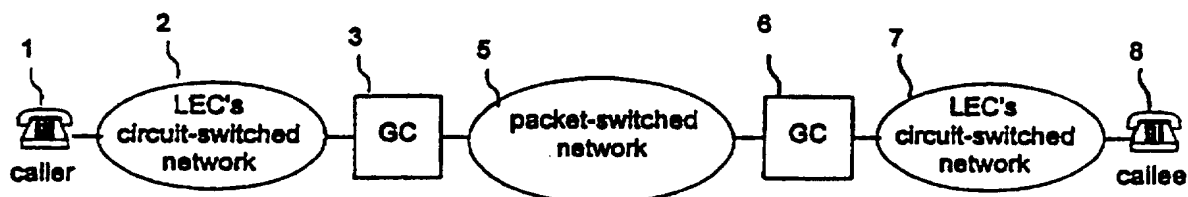
(57) Abstract

A hybrid telephony system with packet switching as well as circuit switching optimizes utilization of transport networks, and is accessible from any conventional telephone set. A call originating from a circuit-switched network (2) is passed through a gateway computer (3) to a backbone packet-switched network (5), and then through a second gateway computer (6) to a second circuit-switched network (7) where it terminates. The voice of both the originating party and the terminating party is converted to data packets by the near-end gateway computer (3) and then converted back to voice by the far-end gateway computer (6). In an alternative scenario, the originating party uses a computer (4) on the packet-switched network (5), which replaces the originating circuit-switched network and the originating computer.

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HYBRID PACKET-SWITCHED

AND CIRCUIT-SWITCHED TELEPHONY SYSTEM

TECHNICAL FIELD

This invention relates to telecommunication systems,

5   and, more particularly, to a hybrid telephony system

comprising both circuit-switched and packet-switched

networks.

BACKGROUND OF THE INVENTION

With the extensive use of personal computers and

10   other data processing facilities both at home and in the

office, there are great needs for improved data

communications. Hence, packet-switched public networks

are being rapidly developed and increasingly

interconnected with each other. These existing packet

15   networks have mostly been serving data communications

traffics as opposed to voice telephony.

Voice and data traffic have significantly different

characteristics. Voice is typically continuous in one

direction for relatively long intervals and tolerant of

20   noise, but sensitive to variations in delay. Data is

bursty and sensitive to noise errors, but tolerant of

moderate delays and variations in arrival times.

Two fundamental different switching techniques have

therefore been traditionally applied to voice and data

25   transmissions. Circuit switching, where switched

connections between users are dedicated for call

duration, is the basis of the present-day switched voice

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telecommunication network. On the other hand, packet

switching, where data packets from multiple terminals

share a single, high-speed line and are switched based on

logical channel numbers attached in the packets, is being

5   rapidly adopted as the basis of the present-day switched

data telecommunication network.

Packet switching was pioneered in the ARPANET

network of the U.S. Department of Defense, and has been

widely implemented in a variety of public data networks.

10   However, most public telephone systems are fundamentally

circuit switched, which is an inherently inefficient

system because typically each subscriber utilizes the

allotted channel for a relatively small amount of the

total connection time. Furthermore, the number of

15   simultaneous circuit-switched communications are limited

because only a portion of the available bandwidth is

allocated to such communications.

Another disadvantage is that, because circuit

switching is centralized, a failure at the switching

20   center can result in failure of the entire network. A

further disadvantage of circuit-switched telephony is due

to the proprietary nature of the telephony switches

currently in use. Because the switching software is

often proprietary and not shared with other

25   manufacturers, the cost and delay in adding and

interfacing new services are often frustrating and

installation prohibiting.

It has been proposed that packet-switched techniques

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replace, or at least be combined with some, circuit-
switched telephony so that the entire system bandwidth
may be made available to each subscriber on a random
access basis. For this purpose, there are currently

5   emerging software products that make use of the Internet,
which is a constantly changing collection of
interconnected packet-switched networks, for telephony.
VOCALTEC software provides half-duplexed long-distance
telephone capability through the Internet. Camelot Corp

10   is another entry in the Internet telephone business with
a MOSAIC front end software that supports full-duplexed
voice conversation. These products offer an alternative
to long-distance analog telephone service for the
subscribers by digitizing and compressing voice signals

15   for transport over the Internet.

Some limitations of this type of hybrid telephone
system are: (1) Both the caller and the callee must have
computers, (2) they must have sound systems on their
computers, (3) they must have full Internet access, (4)

20   they must have both purchased compatible software, (5)
they must both connect to the Internet at the time the
call is made, and (6) the telephony software must be in
execution at both ends at the same moment. These
limitations translate into a considerable amount of

25   investment in hardware and software, which has to be made
by the individual subscribers to implement such a
telephony system. The last limitation also means that
the calls have to be scheduled in advance in most cases,

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which clearly does not provide the convenience of
conventional telephone calls. An additional problem with
such software products is that the performance is
constrained by the capabilities of each computer, such as
5   processor speed, memory capacity, and modem functional
features.

SUMMARY OF THE INVENTION

In accordance with the principles of the present
invention, a hybrid packet-switched and circuit-switched
10   telephony (HPCT) system routes a telephone call mostly
through packet-switched networks, except for the caller
and callee ends where the subscriber telephone sets are
directly connected to the circuit-switched networks of
the respective local exchange carriers (LEC's). A
15   gateway computer (GC) or equivalent interconnects the
packet-switched network to each of the circuit-switched
networks, and converts voice signals into data packets
and vice versa, and resolves the call destinations while
routing the packets.

20   In this invention, the GC's are preferably managed
by the telephony service provider, as opposed to the end-
user. Because the GC's are a set of resources shared by
many subscribers, they can be managed with higher
efficiency and utilization than calls managed by a
25   subscriber's personal computer. By incorporating the
HPCT system into the current long-distance telephony,
lower cost of communication can be achieved due to better

utilization of available channels by packet-switched networks over purely circuit-switched networks, and the benefits of packet switching can be made available to many subscribers without significant subscriber

5   investment. Moreover, there can be special hardware components added to the GC to improve performance, such as a DSP or an ASIC based compressor, decompressor, speech recognizer, encryptor and decryptor, etc., which would be much less cost-effective to added to each home

10 computer.

Additional advantages of the hybrid packet and circuit switched telephony of the invention are: (1) lower cost of transport due to better circuit utilization as compared to a pure circuit-switched network; (2)

15 availability to any subscriber at no initial investment as would be required by pure packet-switched telephony, such as requiring the purchase of a multimedia personal computer, Internet access, and Internet telephony software; (3) the potential for quickly adding

20 intelligent services due to computer based telephony, such as a caller's personalized speed dialing list, a callee's personalized virtual destination number, and integration with electronic mails; and (4) avoidance of the inconvenience of current packet-switched telephony

25 using Internet phones, which includes the burden of learning each callee's IP address and carrying a portable computer when traveling or commuting.

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BRIEF DESCRIPTION OF THE DRAWINGS

The features of the invention and its objects and advantages may be further understood from the detailed description below taken in conjunction with the

5   accompanying drawings, in which:

Fig. 1 is a block diagram showing a first embodiment of the present invention;

Fig. 2 is a block diagram illustrating a voice telephony system before and after incorporating the first

10   embodiment of the present invention;

Fig. 3a is a system block diagram of the first embodiment illustrating structural components of the gateway computer;

Fig. 3b is a system block diagram of the first

15   embodiment illustrating functional components of the gateway computer;

Fig. 4 is a block diagram showing a second embodiment of the present invention;

Fig. 5 is a flow diagram of the calling process for

20   providing a charge call in accordance with the present invention;

Fig. 6 is a sequence diagram of the call signaling for providing the charge call of Fig. 5; and,

Fig. 7 is a flow diagram of the calling process for

25   providing a call from a caller's dedicated telephone in accordance with the present invention.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to Figs. 1 to 3b, a hybrid packet-switched and circuit-switched telephony (HPCT) system according to a preferred embodiment of the present invention comprises originating and terminating gateway computers (GC's), which interconnect corresponding circuit-switched networks with a packet-switched network for voice and data communications.

As shown in Fig. 1, an originating (local) telephone set 1 is connected with an originating (local) GC 3 through a circuit-switched network 2 of an originating local exchange carrier (LEC). At the other end of the telephony system, a terminating (remote) telephone set 8 is connected with a terminating (remote) GC 6 through a terminating (remote) circuit-switched network 5 of a terminating (remote) LEC 7. A packet-switched network 5 is provided for communications between originating GC 3 and terminating GC 6. Fig. 2 shows diagrammatically how a conventional circuit-switched network 10 is replaced by the two GC's 3 and 6 and the packet-switched network 5.

Fig. 3a shows one of the GC's in more detail. Preferably both the originating and terminating GC's include a plurality of digital trunk interfaces 16, a Random Access Memory (RAM) 17, a signaling network interface 18, a non-blocking Time-Division Multiplexing (TDM) bus 19, a plurality of packet network interfaces 20 one of which is connected through the packet-switched network 5 to other gateway computers 3' and 6', a

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plurality of Central Processing Units (CPU's) 21, a
plurality of Digital Signal Processors (DSP's) 22, a
plurality of Application-Specific Integrated Circuits
(ASIC's) 23, a plurality of disk controllers 24 with

5   disks 25, and a system back plane in the form of either a
shared bus or cross connection 29. An analog subsystem
13, comprising analog trunks 14 and A/D and D/A converter
pairs 15, is needed only if analog trunks are to be
supported by the GC, and therefore may be considered

10   optional.

      Fig. 3b shows the functional components of GC's 3
and 6 arranged into media conversion modules 31, optional
analog trunking modules 49, MF and DTMF digit modules 43,
speech processing modules 48, routing resolution modules

15   39, and special services modules 38. Speech processing
modules 48 include a spoken digit recognizer 44
implemented with DSP 22, and a voice prompt playback unit
47 also implemented with DSP 22. Routing modules 39
include an address resolution logic 45 implemented with

20   CPU 21, and a network routing database 46 also
implemented with CPU 21 and possibly shared with other
GC's in a distributed manner. MF and DTMF digit modules
43 include a tone detector 41 implemented with DSP 22 or
ASIC 23 for both user keypad dialing and in-band

25   signaling if needed, and a tone generator 42 also
implemented with DSP 22 or ASIC 23 for prompting and in-
band signaling if needed. Media conversion modules 31
include a plurality of channelized voice bit stream

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buffers 32 implemented with DSP 22 or ASIC 23, a

compressor/decompressor 33 also implemented with DSP 22

or ASIC 23, hardware supervision logic 34 implemented

with digital trunk interfaces 16, and a

5   packetizer/unpacketizer 36 implemented with CPU 21, DSP

22 or ASIC 23. Special services modules 38 may include

an encryptor/decryptor 37 also implemented with CPU 21,

DSP 22 or ASIC 23. As indicated in the preceding

paragraph, the analog trunking modules 49, which include

10   the plurality of analog-to-digital and digital-to-analog

converter pairs 15, are optional. Digit modules 43 and

special services modules 38 are also optional.

        With GC's 3 and 6 having these functions, the

expected voice compression ratio may reach 25:1, or even

15   better with emerging technology. The presence of the

usual amounts of silence in voice communications may

double that ratio to 50:1, making the HPCT even more

efficient and cost-effective. To achieve even further

compression ratios, special compression schemes may also

20   be used, which are expected to be both tolerated by the

human ear and used to facilitate a low cost of the

service. The HPCT may provide a virtual end-to-end

connection. In the absence of such a virtual connection,

the buffering mechanism at the receiving end can recover

25   the stream of voice from packets arriving with the

variable delay introduced by the packet-switched network.

        The HPCT telephony network of Fig. 1, along with its

associated service protocols, is symmetric. However,

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sometimes a caller may have a multimedia-capable computer
and a packet-switched network connection, thereby
enabling advanced services or features. However, if the
callee does not have (a) a terminating multimedia
5   computer, (b) direct access to the packet-switched
network, or (c) a compatible packet-switched telephony
application currently running on the terminating
computer, then the call can not be completed over just a
packet-switched network. In this case, a terminating
10   circuit-switched LEC 7 supported by a terminating GC 6
may be used in the same way as in the first embodiment of
the present invention, but the telephony system will have
an asymmetric configuration as shown in Fig.4.

        In this system, the caller's multimedia computer 4
15   will run a digital communications program comparable to
an originating GC's protocol, and therefore will serve as
the originating GC from the view point of the packet-
switched network 5 and the terminating GC 6, except the
billing and validation of the caller may be performed by
20   the terminating GC 6 based on the caller's access point
to the packet-switched network. Similarly, where the
callee has a multimedia capable computer and a packet-
switched network connection but the caller does not, the
telephony system of the invention may have an asymmetric
25   configuration that is the reverse of the Fig. 4
configuration.

        On the other hand, where the HPCT utilizes gateway
computers at both ends of the packet-switched network,

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each GC provides a set of resources that are shared by
many users and thus achieves much higher utilization in
the telephony than a personal computer. Optimization of
performance can be achieved by using Digital Signal

5   Processors (DSP's) or Application Specific Integrated
Circuits (ASIC's). Furthermore, the users do not have to
make a large investment, operate special computer
equipment and programs, or schedule calls in advance. In
fact, as described below relative to Figs. 5 and 7, the

10   users may not tell any difference between using the HPCT
and using their regular long-distance services, except
for a much lower cost.

          Considering the 50:1 compression ratio discussed
above, the utilization of the circuits in circuit-

15   switched telephony can be only 1/50 as efficient as that
of the HPCT; in other words, the cost of the former can
be as much as 50 times higher than that of the HPCT.
Another important problem with circuit-switched telephony
is the proprietary nature of the telephony switches which

20   are the foundation of this telephony. Because switch
software development is only done by the manufacturers,
the cost and delay in adding new services are often
frustrating and prohibiting. The HPCT, however, is based
on general-purpose computers with open architecture,

25   which can open up development and bring very cost-
effective new services in a much shorter time frame.

          The packet-switched network 5 of the HPCT system can
be one of many types of packet-switched public data

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networks, such as X.25 or the emerging Asynchronous

Transfer Mode (ATM) network. The ATM network is a special

packet-switched network with low delay and low delay

deviation, in which data is formatted into special types

5   of packets, referred to as "cells", to achieve fast-

switching. Accordingly, ATM networks are sometimes

referred to as having a third type of networking, namely

"cell-switched networking".

A caller can use the HPCT system as an alternative

10   long distance telephony service ("charge service"), or

the caller can use it as his/her primary long distance

telephony service ("dedicated service"). Charge service

can be reached from any telephone while dedicated service

can be reached only from a subscriber's dedicated

15   telephone, such as a home phone or office phone. The

alternative service is referred as "charge service"

because the caller does not need to have a dedicated

telephone account with the service provider; instead, the

authorization is via a credit card or calling card

20   inquiry.

To implement the charge service and the dedicated

service, the invention provides two respective protocols

for processing calls within the hybrid telephony system.

The first protocol is for the charge service and is

25   illustrated in Figs. 5 and 6. The process of this

protocol includes the following steps: (1) The caller

first calls a local originating GC through a circuit-

switched originating LEC from any telephone, and the

caller's address (caller's telephone number) is relayed
to the originating GC by the originating LEC. (2) The
originating GC plays a voice prompt (a greeting message
asking for input) to the caller asking for the callee's
5   destination address (callee's telephone number). (3) The
caller provides the address either through telephone
keypad digits or through spoken digits which are
recognized by the originating GC. (4) The originating GC
resolves the call routing information in a manner similar
10   to the Domain Name Service for the Internet, obtains the
packet network address (such as the IP address of the
Internet) of the terminating GC, which is usually local
to the callee (otherwise a toll call may be involved),
and estimates the unit charge for a call going through
15   that terminating GC. (5) The originating GC informs the
caller about the charge rate, and asks for the caller's
preferred payment method, such as by credit card, or
through a prearranged calling card account. (6) The
caller specifies the payment method either through keypad
20   digits or through spoken digits which again are
recognized by the originating GC (if this is a collect
call, then the caller's spoken information about both
parties is recorded and digitized to be announced later
to the callee). (7) The originating GC validates the
25   payment method through an internal or external database.
(8) The originating GC sends a control message to the
terminating GC, along with both party's addresses and, if
the terminating GC does not know where to route the call

or does not have the resources to serve the call, it
responds with a negative acknowledgment and an
alternative terminating GC is searched for and selected,
or the caller is informed that the call can not be routed
at that moment.   (9) The terminating GC dials out to the
callee through a circuit switched terminating LEC using
the destination address it obtained from the originating
GC.   (10) If the call proceeds successfully through the
terminating LEC, the terminating GC sends an
acknowledgment back to the originating GC (or if the call
proceeds unsuccessfully, such as due to busy telephone
lines, the terminating GC sends this status to the
originating GC in the form of a busy message).   (11) The
originating GC then passes the status of the
acknowledgment back to the caller through the originating
LEC, the effect being a ring back tone (or a busy tone).
(12) The callee answers the call.   (13) The terminating
GC passes this state change to the originating GC, which
may begin billing at that time.   (14) The callee starts
the conversation by greeting the caller.   (15) The
terminating GC either receives the digitized voice data
stream over a digital trunk or continuously digitizes all
the voice signals over an analog trunk from the LEC which
the callee is connected to, and, after possibly
encrypting and compressing, packetizes the data into
packet form, the packets then being sent over the packet-
switched network to the originating GC.   (16) The
originating GC, after possibly rearranging the packets to

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maintain proper packet order, unpacketizes the received

data and, after possibly decompressing and decrypting,

optionally converts the digitized data back to the voice

signal if the connection with the LEC to which the caller

5   is connected is analog. The digital or voice signal is

then routed to the caller over the circuit-switched

network of the originating LEC. (17) The same process as

described in steps 14 through 16 is performed for the

caller's voice in the opposite direction. The resulting

10   processing in both directions supports the conversation

between the two parties participating in the call.

Each GC preferably provides out-of-band signaling,

and the call signaling sequence for providing the charge

call of Fig. 5 will now be described with reference to

15   Fig. 6. (1) The caller's telephone number is sent to the

originating GC to access a call. (2) The originating GC

prompts for a destination address, such as by a dial

tone. (3) The caller inputs the callee's address, such

as by dialing the callee's telephone number. (4) The

20   originating GC may provide a voice message regarding

rate, and prompts for a payment method, such as by a

special tone or by a voice message. (5) The caller

inputs the desired method of payment, such as keypad

numbers corresponding to a credit card. (6) The

25   originating GC validates the payment method and then

sends a connection request to the terminating GC. (7)

The terminating GC dials the callee through the

terminating LEC. (8) Depending on whether the callee's

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telephone is available or busy, the terminating GC sends
a corresponding acknowledgement to the originating GC.
(9) Depending on whether the callee's telephone is
available or busy, the originating GC sends a ring back
5   tone or a busy signal to the caller's telephone. (10) If
the callee answers the telephone, an off-hook signal is
sent to the terminating GC. (11) The terminating GC then
sends an answer indication to the originating GC, which
starts billing and sets up the in-band routing for both
10   digitized voice data and analog voice transmission. (12)
At this stage, either the callee or the caller may
initiate the conversation. If initiated by the callee,
the callee's telephone sends the voice greeting to the
terminating GC. (13) The terminating GC either receives
15   digitized voice data in a bit stream from the terminating
LEC or digitizes the analog voice, and may also perform
the additional functions previously described, and then
sends the digitized voice data to the originating GC.
(14) The originating GC converts the voice data to analog
20   voice by performing the functions previously described,
and sends the analog voice to the caller.

        The second protocol is for the dedicated service on
the HPCT telephony system of the invention and is shown
in Fig.7. The process of this protocol includes the
25   following steps: (1) The caller initiates a long-
distance call by dialing a destination address (callee's
telephone number) through the circuit-switched network of
an LEC from his/her dedicated telephone, such as a home

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phone or office phone, for which a routing configuration
to an originating GC is present within the LEC. The LEC
routes the call to this GC, and the caller's address
(caller's telephone number) is passed to the GC by the
5   LEC, along with the destination address. (2) The
originating GC authorizes the call by checking the
caller's account information through an internal database
or may communicate with a centralized database for the
account information, and it also resolves the call
10   routing information using the dialed destination address.
(3) The originating GC then sends a control message to a
terminating GC, along with both party's addresses. If
the first terminating GC does not know where to route the
call or does not have the resources to service the call,
15   it responds with a negative acknowledgment and an
alternate terminating GC is searched for and selected, or
the caller is informed of the negative acknowledgement.
(4) The terminating GC dials out to the callee through
the circuit-switched network of the terminating LEC. (5)
20   If the call proceeds successfully through the terminating
LEC, the terminating GC sends an acknowledgment back to
the originating GC (the handling of the unsuccessful,
most likely busy, scenario is similar to that in the
first protocol). (6) The originating GC then passes the
25   status back to the caller through the originating LEC,
the effect being a ring-back tone. (7) The callee
answers the call. (8) The terminating GC passes this
state change to the originating GC which may start

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charging.   (9) The callee initiates the conversation by
greeting the caller.   (10) The terminating GC either
receives digitized voice data in a bit stream from the
terminating LEC or continuously digitizes all the voice
5   signals from the callee, possibly encrypts and
compresses, and packetizes the data into packets, the
packets then being sent over the packet-switched network
to the originating GC.   (11) The originating GC, after
possibly rearranging the packets to maintain proper
10   packet order, unpacketizes the data, possibly
decompresses and decrypts, and optionally converts the
digitized data back to the voice signal if the connection
with the originating LEC is analog.   The digital or voice
signal is then routed to the caller over the circuit-
15   switched network of the originating LEC.   (12) The same
process described in steps 9 through 11 is performed for
the caller's voice, except in the opposite direction.
This processing in both directions supports the
conversation between the two parties participating in the
20   call.

        While the present invention has been described in
connection with a system having a circuit-switched
network in the form of both a digital and an analog local
exchange carrier (LEC) serving analog telephone sets, it
25   is likely that there are many instances where only the
digital network interface is needed to connect to the
LEC.   With a digital circuit-switched network, the
configuration of the corresponding GC's is simplified

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since it is no longer necessary for the data manipulator
to convert the voice signal into digital data, and vice
versa.

    From the foregoing, it can be seen that the present
invention provides an improved telephony system which
effectively integrates voice and data in a hybrid
circuit-switched and packet-switched telephony network,
while ensuring real-time high quality voice communication
and calling services with low transmission and access
costs. By utilizing gateway computers of telephony
service providers to route calls between circuit-switched
and packet-switched telephone networks, HPCT provides the
benefits of packet switching to any telephone subscriber,
with none of the substantial initial investments required
by pure packet-switched telephony. The potential for
vastly increased intelligent services due to computer
based telephony, such as caller's personalized speed
dialing list, callee's personalized virtual destination
number, integration with electronic mails, and many
others, allows for even further enhancement of the HPCT
system. Furthermore, the HPCT system, which is based on
general-purpose computers with open architecture, can
open development of a host of new services and make them
cost-effective in a much shorter time than would be
required for complete conversion from conventional
circuit-switched networks to entirely packet-switched
networks.

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While this invention has been described in the context of preferred embodiments comprising at least one circuit-switched network of an LEC, it should be clear that the principles of the invention will work equally

5   well with other telecommunications networks and with variations of the preferred embodiments. These and many other modifications and alternatives are possible and will occur to those skilled in the art who become familiar with the present invention. Such modifications

10   and alternatives are intended to be within the scope of the invention as defined by the claims set forth below.

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CLAIMS

What is claimed is:

1.   A telecommunications system comprising:

an originating circuit-switched network for providing originating signals in response to voice input;

5   an originating gateway computer for converting said originating signals into packets of digital data,

a terminating gateway computer for converting said digital packets into terminating signals,

10   a terminating circuit-switched network for providing voice output in response to said terminating signals, and

a packet-switched network for transmitting said digital packets from said originating gateway

15   computer to said terminating gateway computer, at least one of said originating and terminating gateway computers comprising a component for routing said digital packets through said packet-switched network from said originating gateway computer to said terminating gateway

20   computer.

2.   A telecommunications system according to claim 1, wherein said originating gateway computer comprises a component for compressing said digital data, and wherein said terminating gateway computer comprises a component

5   for decompressing said digital data.

3. A telecommunications system according to claim 1, wherein said originating gateway computer comprises a component for encrypting said digital data, and wherein said terminating gateway computer comprises a component for decrypting said digital data.

4. A telecommunications system according to claim 1, wherein said terminating gateway computer comprises a terminating buffer component for storing said digital packets prior to the conversion thereof into said terminating voice signals.

5. A telecommunications system according to claim 4, wherein said terminating gateway computer further comprises a component for rearranging said stored digital packets to maintain a proper packet order.

6. A telecommunications system according to claim 1, wherein said routing component provides said routing in response to dialed digits.

7. A telecommunications system according to claim 1, wherein said routing component provides said routing in response to spoken digits.

8. A telecommunications system according to claim 1, wherein said terminating circuit-switched network is capable of providing first return signals to said terminating gateway computer in response to return voice input, wherein said terminating gateway computer comprises a component for converting said first return signals into packets of return digital data; wherein at least one of said originating and terminating gateway

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computers comprises a component for routing said return
packets through said packet-switched network from said
terminating gateway computer to said originating gateway
computer; and wherein said originating gateway computer
comprises a component for converting said return packets
into second return signals.

9.   A telecommunications system according to claim
8, wherein said originating gateway computer comprises an
originating buffer component for storing said return
packets prior to conversion thereof into said second
return signals.

10.   A telecommunications system according to claim
9, wherein said originating gateway computer further
comprises a component for rearranging said stored return
packets to maintain a proper packet order.

11.   A telecommunications system comprising:

an originating network for providing
digital packets corresponding to originating signals
produced in response to voice input,

a gateway computer for converting said
digital packets into terminating signals,

a circuit-switched network for providing
voice output in response to said terminating signals, and

a packet-switched network for transmitting
said digital packets from said originating network to
said gateway computer, at least one of said originating
network and said gateway computer comprising a component
for routing said digital packets through said packet-

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switched network from said originating network to said
gateway computer.

15

12.   A telecommunications system according to claim
11, wherein said originating network comprises a
component for compressing said digital data, and wherein
said gateway computer comprises a component for
decompressing said digital data.

13.   A telecommunications system according to claim
11, wherein said originating network comprises a
component for encrypting said digital data, and wherein
said gateway computer comprises a component for
decrypting said digital data.

14.   A telecommunications system according to claim
11, wherein said gateway computer comprises a buffer
component for storing said digital packets prior to the
conversion thereof into said terminating voice signals.

15.   A telecommunications system according to claim
14, wherein said gateway computer further comprises a
component for rearranging said stored digital packets to
maintain a proper packet order.

16.   A telecommunications system according to claim
11, wherein said routing component provides said routing
in response to data received from said gateway computer.

17.   A telecommunications system according to claim
11, wherein said routing component provides said routing
in response to a typed input from a computer keyboard.

18.   A telecommunications system according to claim
11, wherein said circuit-switched network is capable of

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providing first return signals to said gateway computer;
wherein said gateway computer comprises a component for
converting said first return signals into packets of
return digital data; wherein at least one of said
originating network and said terminating gateway computer
comprises a component for routing said return packets
through said packet-switched network from said gateway
computer to said originating network; and wherein said
originating network comprises a component for converting
said return packets into second return signals.

19. A telecommunications system according to claim
18, wherein said originating network comprises a buffer
component for storing said return packets prior to
conversion thereof into said second return signals.

20. A telecommunications system according to claim
19, wherein said originating network further comprises a
component for rearranging said stored return packets to
maintain a proper packet order.

21. A telecommunications system comprising:

a terminating network for providing voice
output in response to terminating signals corresponding
to terminating digital packets and for providing return
digital packets corresponding to return signals produced
in response to voice input,

a gateway computer for converting said
return digital packets into return signals,

a circuit-switched network for providing
voice output in response to said return signals, and

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a packet-switched network for transmitting
said return digital packets from said terminating network
to said gateway computer and for transmitting said
terminating digital packets from said gateway computer to
said terminating network, at least one of said
terminating network and said gateway computer comprising
a component for routing said digital packets through said
packet-switched network between said terminating network
and said gateway computer.

22. A telecommunications method comprising steps
of:

providing digital packets for transmission
from an originating network, said digital packets
corresponding to originating signals produced in response
to voice input,

transmitting said digital packets from
said originating network to a gateway computer through a
packet-switched network, at least one of said originating
network and said gateway computer comprising a component
for routing said digital packets through said packet-
switched network from said originating network to said
gateway computer,

converting said digital packets into
terminating signals for transmission from said gateway
computer, and

transmitting said terminating signals
through a circuit-switched network for providing voice
output in response to said terminating signals.

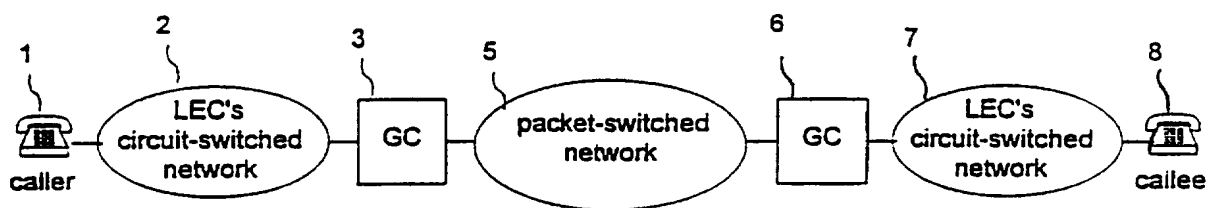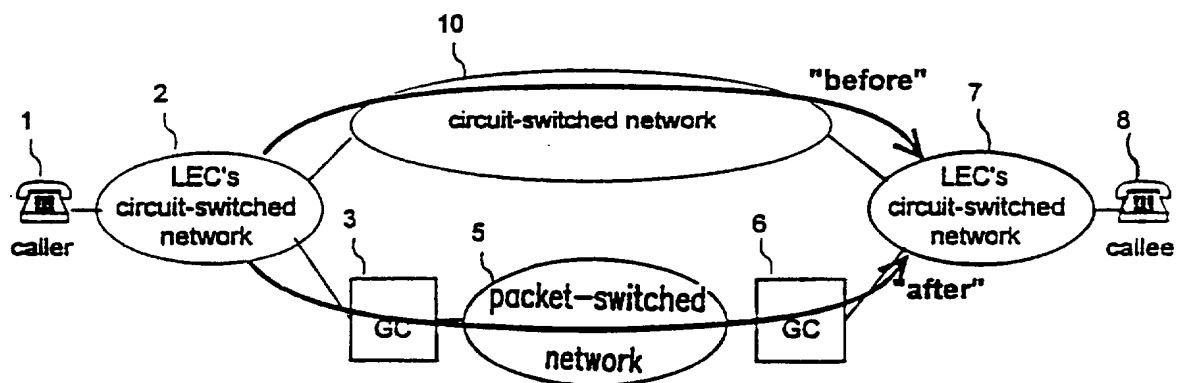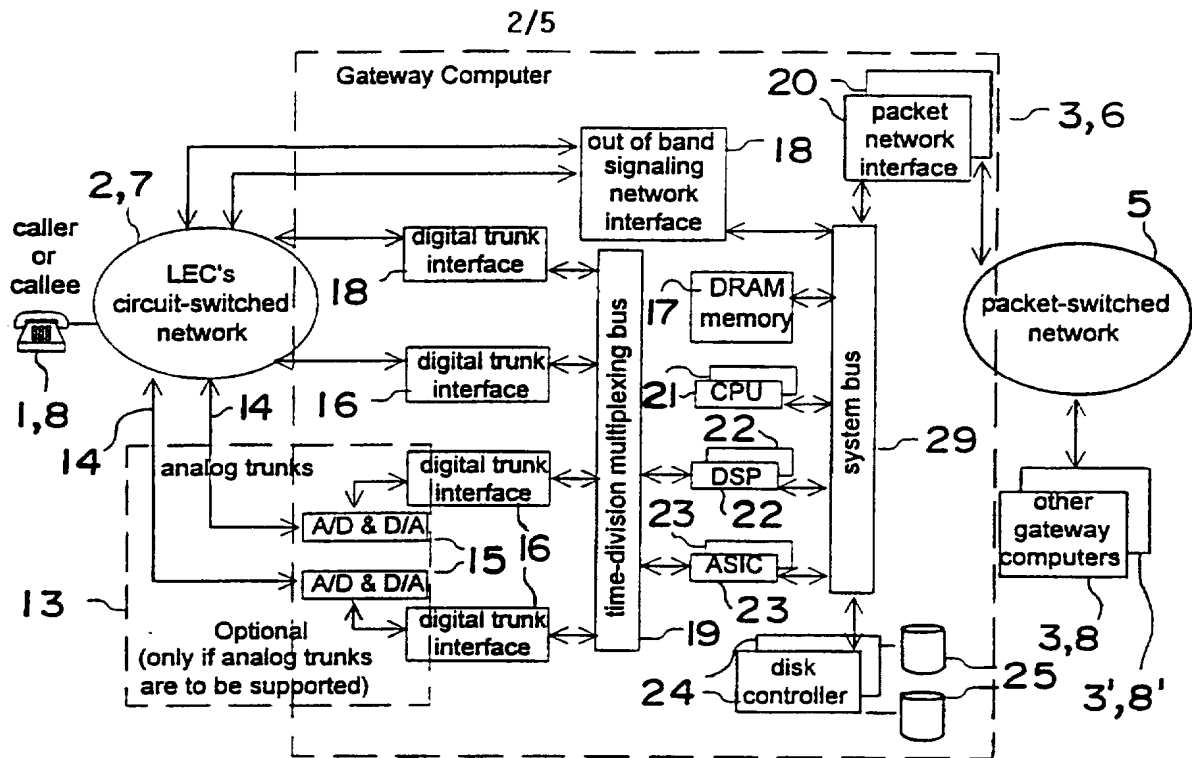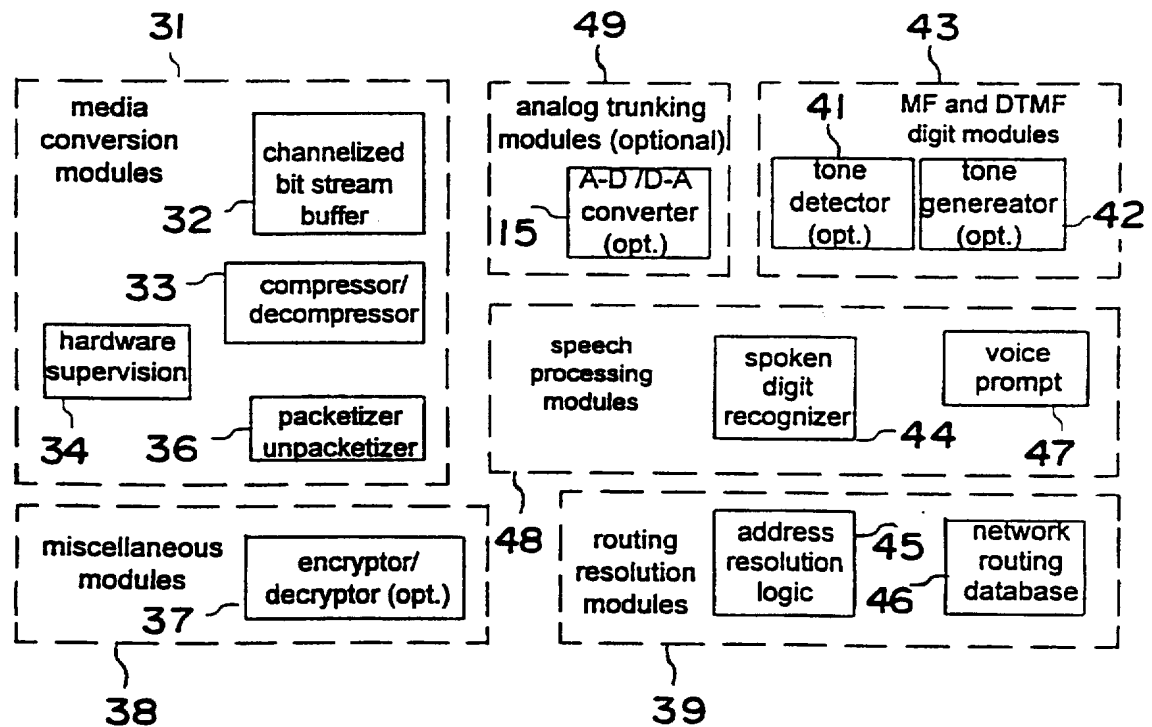FIG. 1

FIG. 2

FIG. 3a

FIG. 3b

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FIG. 4

FIG. 6

(1) The caller first calls a local GC ("originate GC") through a Local Exchange Carrier (LEC) from any telephone; the caller's address (caller's telephone number) is usually passed to the GC by the LEC;

↓

(2) The originate GC plays a voice prompt (a greeting message asking for input) to the caller for the callee's destination address (callee's telephone number).

↓

(3) The caller provides the address either through telephone keypad digits or through spoken digits which are recognized by the GC;

↓

(4) The originate GC resolves the address similar to the Domain Name Service for the Internet and obtains the packet network address (such as the IP address of the Internet) of the terminate GC, which is usually local to the callee (otherwise a toll call may be involved). Meanwhile, it estimates the unit charge for a call going through that terminate GC;

↓

(5) The originate GC informs the caller about the charge rate, and asks for caller's preferred payment method, such as by credit card, or through an existing user account.

↓

(6) The caller specifies the payment method either through keypad digits or through spoken digits which are recognized by the GC; If this is a collect call, then the caller's spoken information about both parties are recorded and digitized to be announced later to the callee (scenario not shown);

↓

(7) The originate GC validates the payment method through internal or external databases;

↓

(8) The originate GC sends a control message the terminate GC, along with both parties addresses; if the terminate GC does not know where to route the call or does not have the resource to serve the call, it responds with a negative acknowledgment and an alternate terminate GC is searched for, or the caller is so informed (not shown);

↓

(9) The terminate GC dials out to the callee through his/her LEC.

↓

(10) If the call proceeds successfully through the LEC, the terminate GC sends an acknowledgment back to the originate GC (the unsuccessful, mostly busy, scenario is not shown);

↓

(11) The originate GC then passes the status back to the caller through the LEC, the effect being a ring back tone;

↓

(12) The callee answers the call;

↓

(13) The terminate GC passes this state change to the originate GC which may start billing;

↓

(14) The callee starts the conversation by greeting the caller;

↓

(15) The terminate GC continuously digitizes all the signals from the callee, possibly encrypts, compresses, and packs into packets the data, and sends the packets over the network to the originate GC;

↓

(16) The originate GC continuously unpacks, decompresses, and possibly decrypts, the data, and converts the data back to voice to the caller over the LEC;

↓

(17) The same process is performed for the caller's voice, in the opposite direction of the one described in steps 12 through 14; the processing in both directions supports the conversation between the two parties in the call.

FIG. 5
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(1) The caller makes a long-distance call by dialing a destination address (callee's telephone number) through a Local Exchange Carrier (LEC) from his/her dedicated telephone such as home phone or office phone for which a routing configuration to a Gateway Computer (GC) is preset with the LEC. The LEC routes the call to the GC. The caller's address (caller's telephone number) is usually passed to the GC by the LEC along with the destination address.

↓

(2) The originate GC authorizes the call by checking the caller's account information through internal databases; It also resolves the routing using the dialed destination address.

↓

(3) The originate GC then sends a control message the terminate GC, along with both parties addresses; if the terminate GC does not know where to route the call or does not have the resource to serve the call, it responds with a negative acknowledgment and an alternate terminate GC is searched for, or the caller is so informed.

↓

(4) The terminate GC dials out to the callee through his/her LEC.

↓

(5) If the call proceeds successfully through the LEC, the terminate GC sends an acknowledgment back to the originate GC (the unsuccessful, mostly busy, scenario is not shown);

↓

(6) The originate GC then passes the status back to the caller through the LEC, the effect being a ring back tone;

↓

(7) The callee answers the call;

↓

(8) The terminate GC passes this state change to the originate GC which may start billing;

↓

(9) The callee starts the conversation by greeting the caller;

↓

(10) The terminate GC continuously digitizes all the signals from the callee, possibly encrypts, compresses, and packs into packets the data, and sends the packets over the network to the originate GC;

↓

(11) The originate GC continuously unpacks, decompresses, and possibly decrypts, the data, and converts the data back to voice to the caller over the LEC;

↓

(12) The same process is performed for the caller's voice, in the opposite direction of the one described in steps 9 through 11; the processing in both directions supports the conversation between the two parties in the call.
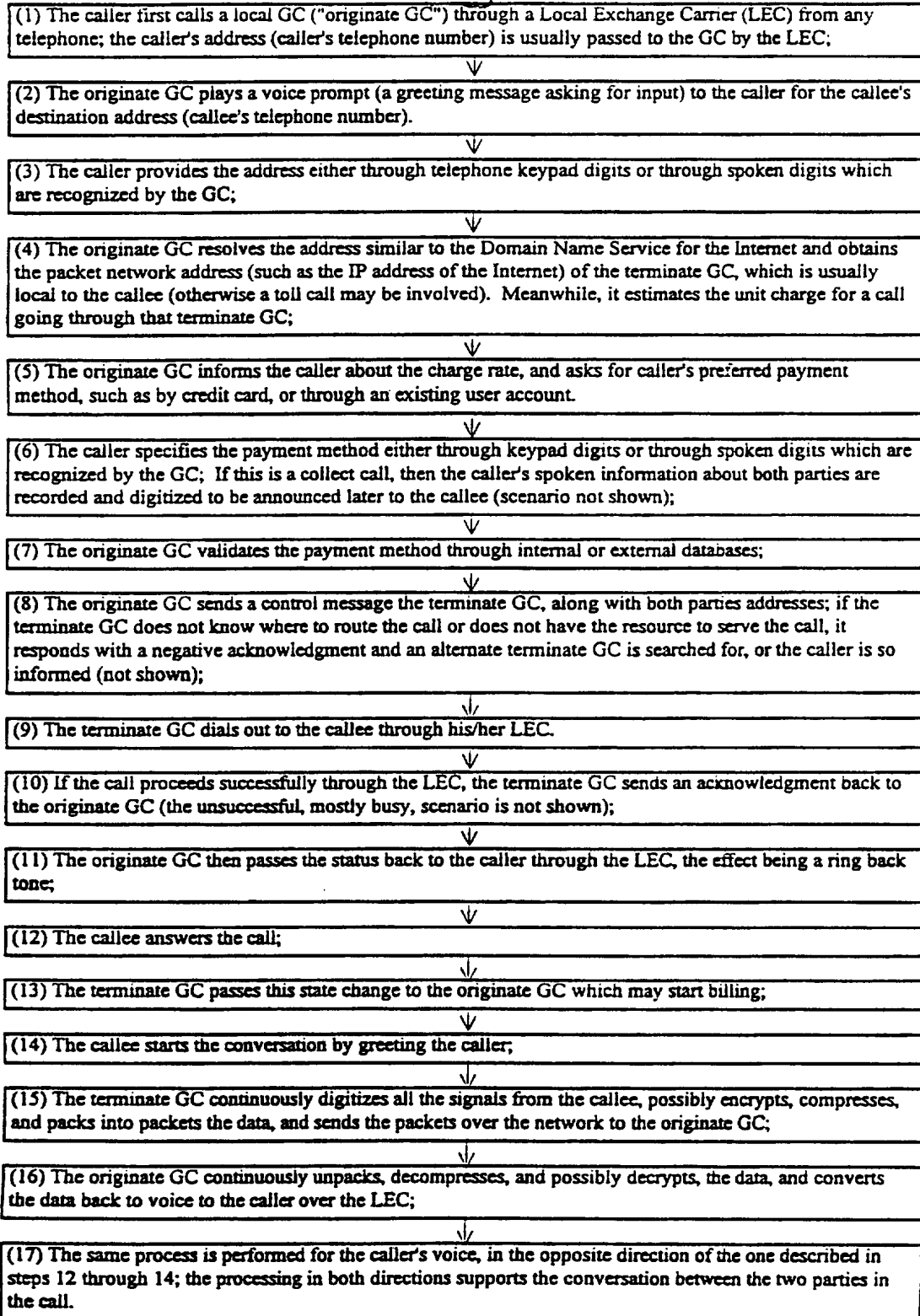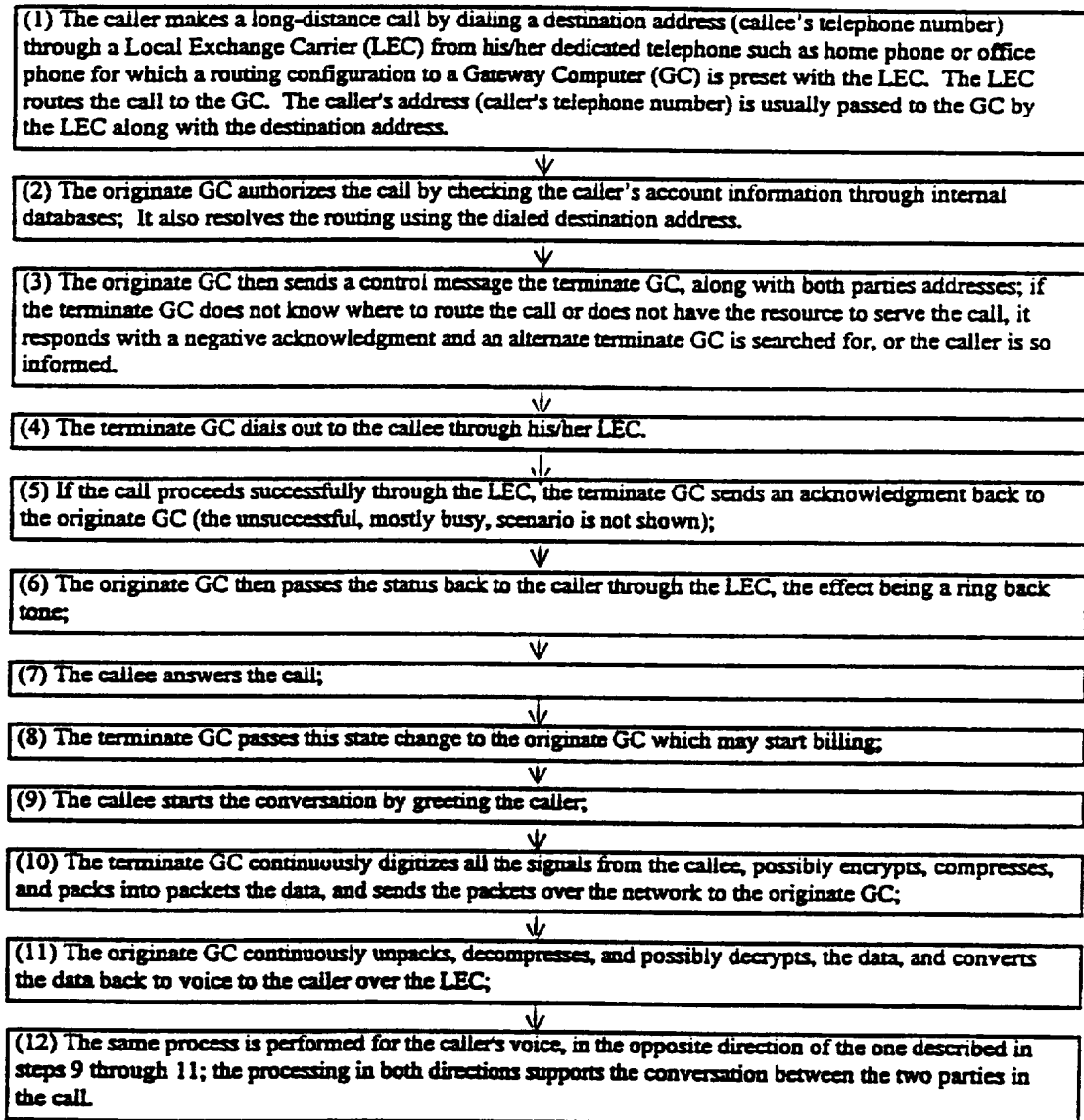
FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/19546

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :H04L 12/56
US CL :370/356, 401, 466
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/352-357, 401, 402, 465, 466; 379/219, 220

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	US, 5,521,924 A (KAKUMA ET AL) 28 MAY 1996, col. 4, line 16 - col. 5, line 29.	1-7, 11-17 & 21-22
A,P	US, 5,541,930 A (KLINGMAN) 30 JULY 1996, see ABSTRACT.	1-22

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

Date of the actual completion of the international search	Date of mailing of the international search report
02 MARCH 1997	27 MAR 1997

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